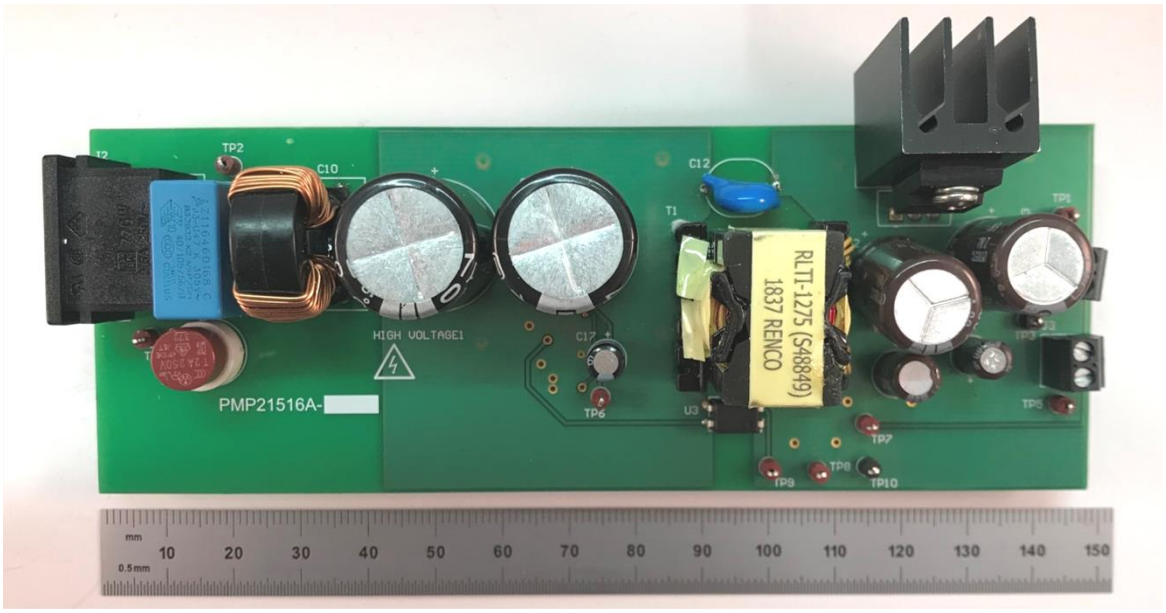
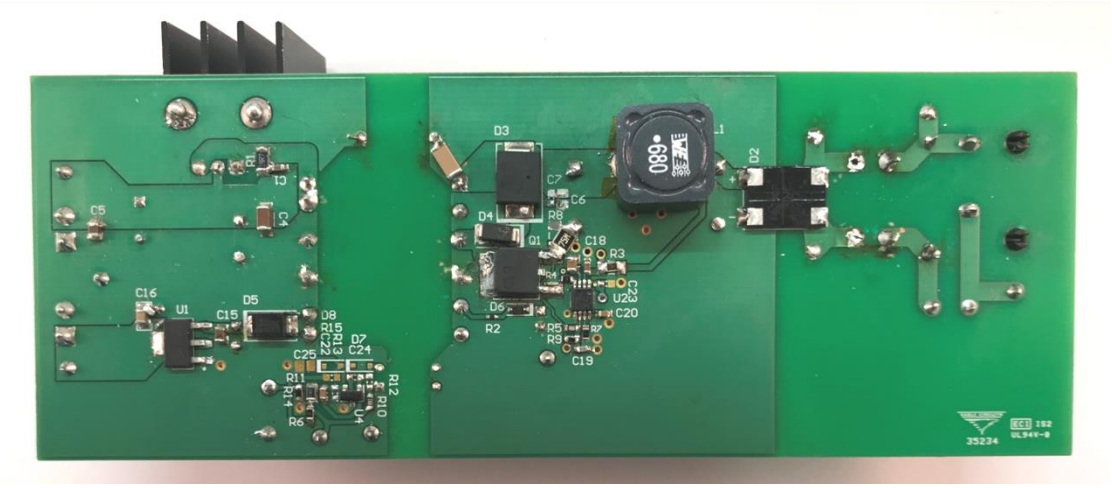
Test Report: PMP21516
50/100-W Flyback reference design for audio applications

Description

This reference design implements a dual-output flyback using the cost effective LM5021 AC-DC Current-Mode PWM Controller. Universal line input is converted to both 24-V and 6-V outputs. The TLV1117 Fixed LDO Voltage Regulator converts the 6-V output to 3.3 V and can handle 0.2 A of current. The supply is designed for sustained operation at 50 W and is rated for peaks up to 100 W, which is ideal for the power requirements of audio signals.





1 Test Prerequisites

1.1 Voltage and Current Requirements

Table 1. Voltage and Current Requirements

PARAMETER	SPECIFICATIONS
Line Input Voltage Range	90 to 265 VAC
Line Input Frequency	50 to 60Hz
Output Voltage/Current	24-V at 2.25-A/ 4.5-A, 3.3-V at 0.2-A
Nominal Switching Frequency	109.8 kHz

1.2 Required Equipment

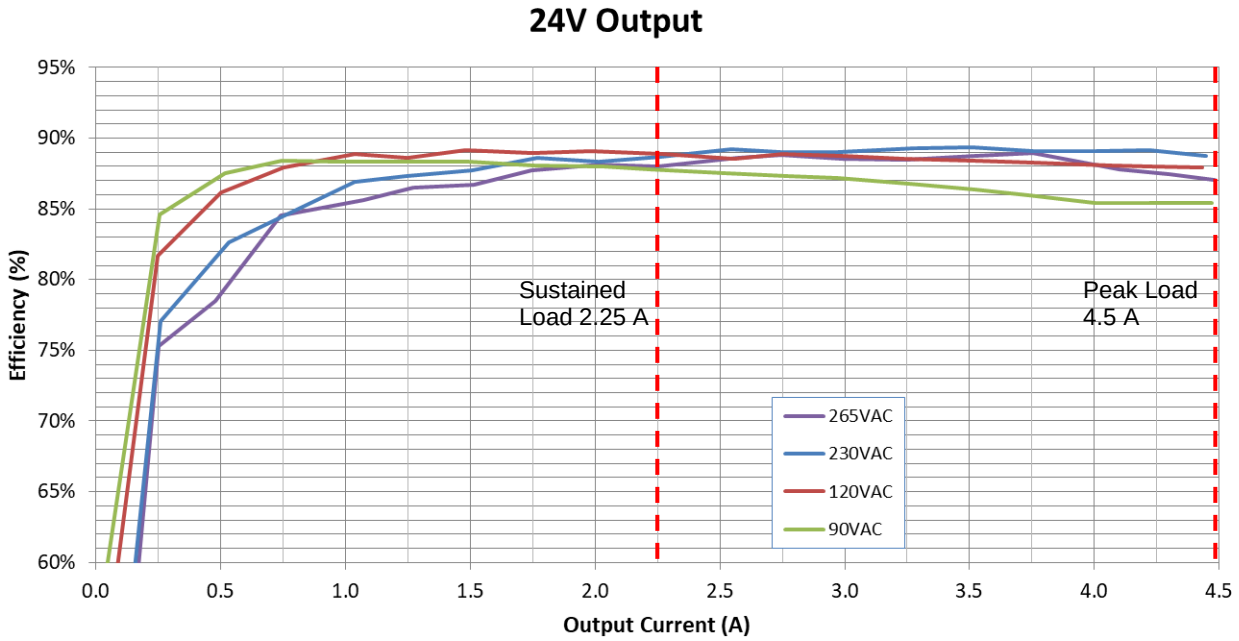
- AC voltage source
- AC power meter
- Electronic load
- Multi-meters
- Oscilloscope

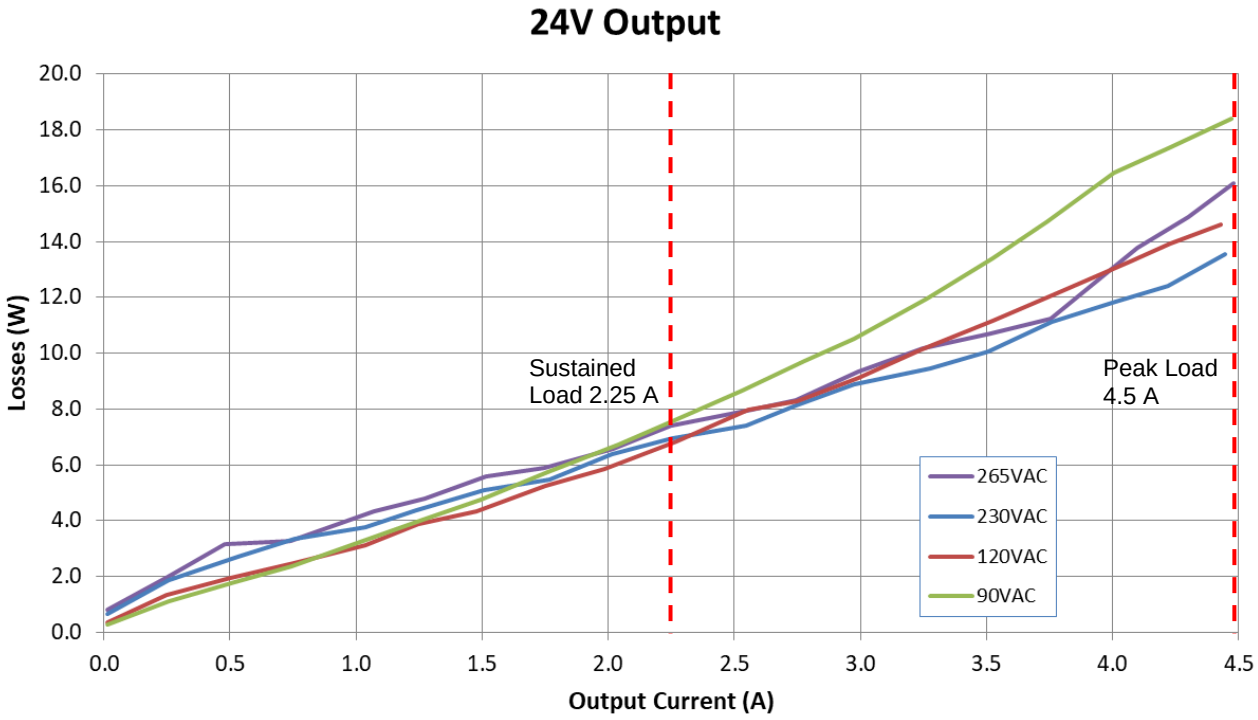
1.3 Considerations

The 6-V output needs 20 mA drawn from the 24-V load to reliably go to full load through the LDO.

2 Testing and Results

2.1 Efficiency Graphs





2.2 Efficiency Data

2.2.1 265VAC, 50Hz

VOUT (V)	IOUT (A)	POUT (W)	PIN (W)	PF	EFFICIENCY	PLOSS (W)
24.1200	0.0140	0.3377	1.1450	0.0910	29.49%	0.8073
24.1200	0.2520	6.0782	8.0740	0.3270	75.28%	1.9958
24.1200	0.4790	11.5535	14.7200	0.3850	78.49%	3.1665
24.1200	0.7410	17.8729	21.1500	0.4140	84.51%	3.2771
24.1200	1.0700	25.8084	30.1500	0.4370	85.60%	4.3416
24.1200	1.2730	30.7048	35.4900	0.4470	86.52%	4.7852
24.1200	1.5140	36.5177	42.1100	0.4580	86.72%	5.5923
24.1100	1.7440	42.0478	47.9300	0.4740	87.73%	5.8822
24.1100	2.0190	48.6781	55.2500	0.4770	88.11%	6.5719
24.1100	2.2510	54.2716	61.6800	0.4840	87.99%	7.4084
24.1100	2.5680	61.9145	69.8900	0.4920	88.59%	7.9755
24.1100	2.7450	66.1820	74.5000	0.4960	88.83%	8.3181
24.1100	2.9920	72.1371	81.4600	0.5020	88.56%	9.3229
24.1100	3.2450	78.2370	88.4100	0.5060	88.49%	10.1731
24.1100	3.5150	84.7467	95.4600	0.5110	88.78%	10.7134
24.1100	3.7540	90.5089	101.7400	0.5140	88.96%	11.2311
24.1100	4.1000	98.8510	112.6200	0.5200	87.77%	13.7690
24.1100	4.3000	103.6730	118.5500	0.5230	87.45%	14.8770
24.1100	4.4800	108.0128	124.1200	0.5250	87.02%	16.1072

2.2.2 230VAC, 50Hz

VOUT (V)	IOUT (A)	POUT (W)	PIN (W)	PF	EFFICIENCY	PLOSS (W)
24.12	0.015	0.3618	1.000	0.120	36.18%	0.6382
24.11	0.259	6.2445	8.106	0.361	77.04%	1.8615
24.11	0.531	12.8024	15.497	0.408	82.61%	2.6946
24.11	0.756	18.2272	21.570	0.429	84.50%	3.3428
24.11	1.036	24.9780	28.740	0.446	86.91%	3.7620
24.11	1.240	29.8964	34.250	0.456	87.29%	4.3536
24.11	1.508	36.3579	41.440	0.467	87.74%	5.0821
24.11	1.768	42.6265	48.090	0.475	88.64%	5.4635
24.11	2.014	48.5575	54.950	0.482	88.37%	6.3925
24.11	2.255	54.3681	61.300	0.488	88.69%	6.9320
24.11	2.547	61.4082	68.810	0.495	89.24%	7.4018
24.11	2.745	66.1820	74.320	0.499	89.05%	8.1380
24.11	2.973	71.6790	80.550	0.503	88.99%	8.8710
24.11	3.277	79.0085	88.470	0.508	89.31%	9.4615
24.11	3.507	84.5538	94.620	0.512	89.36%	10.0662
24.11	3.760	90.6536	101.770	0.516	89.08%	11.1164
24.11	4.010	96.6811	108.540	0.520	89.07%	11.8589
24.11	4.220	101.7442	114.140	0.524	89.14%	12.3958
24.11	4.447	107.2172	120.780	0.527	88.77%	13.5628

2.2.3 120VAC, 60Hz

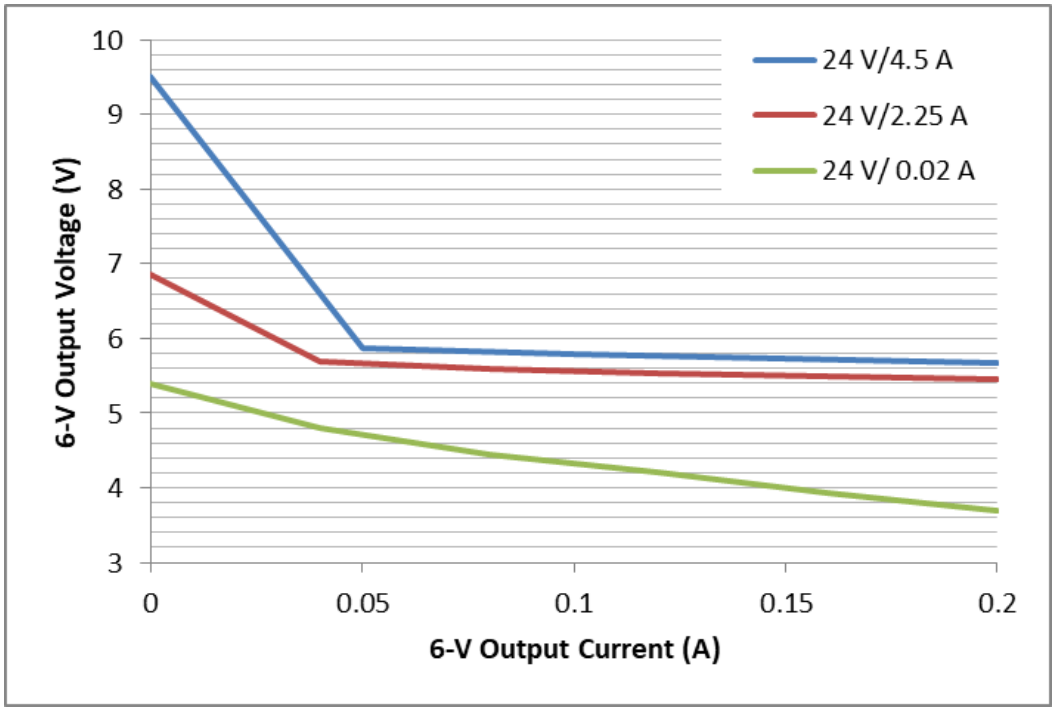
VOUT (V)	IOUT (A)	POUT (W)	PIN (W)	PF	EFFICIENCY	PLOSS (W)
24.12	0.014	0.3377	0.680	0.214	49.66%	0.3423
24.12	0.248	5.9805	7.320	0.453	81.70%	1.3395
24.12	0.500	12.0575	13.989	0.494	86.19%	1.9315
24.12	0.751	18.1104	20.600	0.518	87.91%	2.4896
24.11	1.035	24.9539	28.080	0.536	88.87%	3.1262
24.11	1.248	30.0893	33.950	0.546	88.63%	3.8607
24.11	1.479	35.6587	40.000	0.554	89.15%	4.3413
24.11	1.750	42.1925	47.430	0.563	88.96%	5.2375
24.11	1.985	47.8584	53.720	0.569	89.09%	5.8617
24.11	2.272	54.7779	61.630	0.574	88.88%	6.8521
24.11	2.557	61.6493	69.630	0.579	88.54%	7.9807
24.11	2.750	66.3025	74.590	0.592	88.89%	8.2875
24.11	2.991	72.1130	81.230	0.585	88.78%	9.1170
24.11	3.243	78.1887	88.310	0.595	88.54%	10.1213
24.11	3.525	84.9878	96.130	0.597	88.41%	11.1423
24.11	3.758	90.6054	102.670	0.597	88.25%	12.0646
24.11	4.070	98.1277	111.430	0.600	88.06%	13.3023
24.11	4.230	101.9853	115.900	0.600	87.99%	13.9147
24.11	4.430	106.8073	121.420	0.600	87.97%	14.6127

2.2.4 90VAC, 60Hz

VOUT (V)	IOUT (A)	POUT (W)	PIN (W)	PF	EFFICIENCY	PLOSS (W)
24.12	0.015	0.3618	0.641	0.287	56.44%	0.2792
24.12	0.255	6.1506	7.268	0.489	84.63%	1.1174
24.12	0.516	12.4433	14.217	0.531	87.52%	1.7737
24.12	0.744	17.9416	20.290	0.552	88.43%	2.3484
24.12	0.992	23.9221	27.080	0.567	88.34%	3.1579
24.12	1.265	30.5055	34.520	0.578	88.37%	4.0145
24.11	1.494	36.0203	40.770	0.585	88.35%	4.7497
24.11	1.759	42.4095	48.150	0.596	88.08%	5.7405
24.11	2.038	49.1362	55.850	0.602	87.98%	6.7138
24.11	2.222	53.5724	61.020	0.603	87.79%	7.4476
24.11	2.528	60.9501	69.620	0.604	87.55%	8.6699
24.11	2.778	66.9776	76.710	0.606	87.31%	9.7324
24.11	2.973	71.6790	82.190	0.605	87.21%	10.5110
24.11	3.262	78.6468	90.600	0.603	86.81%	11.9532
24.11	3.523	84.9395	98.350	0.603	86.36%	13.4105
24.11	3.740	90.1714	104.880	0.601	85.98%	14.7086
24.11	4.006	96.5847	113.050	0.593	85.44%	16.4653
24.11	4.220	101.7442	119.070	0.590	85.45%	17.3258
24.11	4.470	107.7717	126.170	0.587	85.42%	18.3983

2.3 Cross Regulation

2.3.1 6V Cross Regulation, measured at 230 VAC/50 Hz



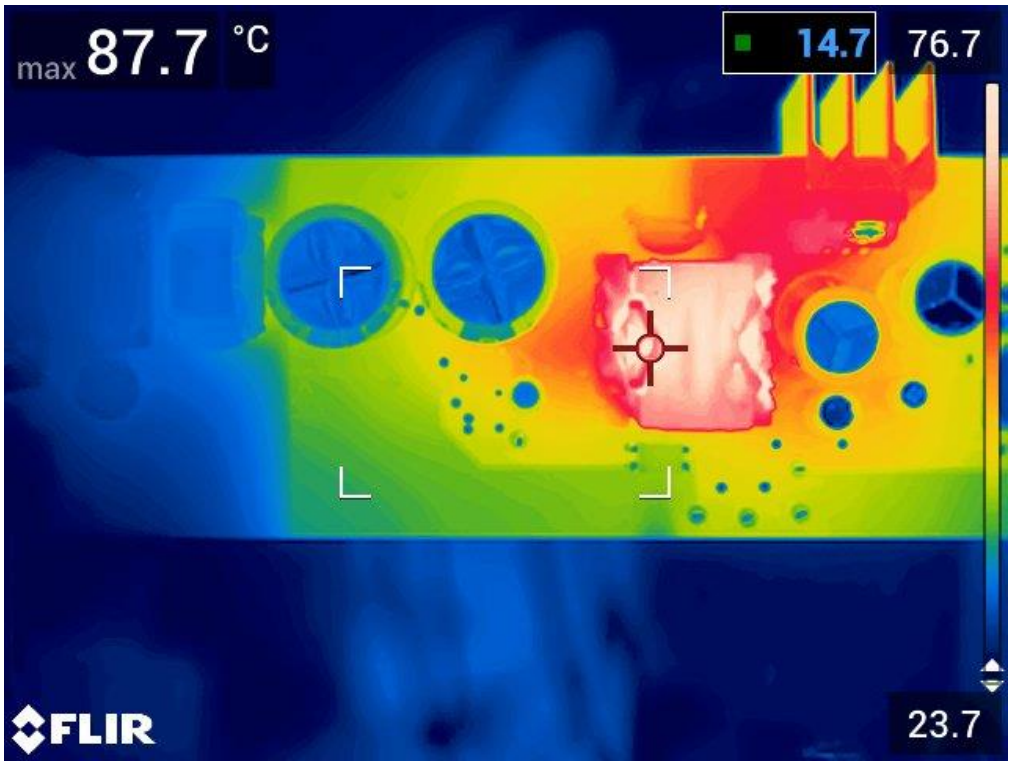
2.4 Standby Power

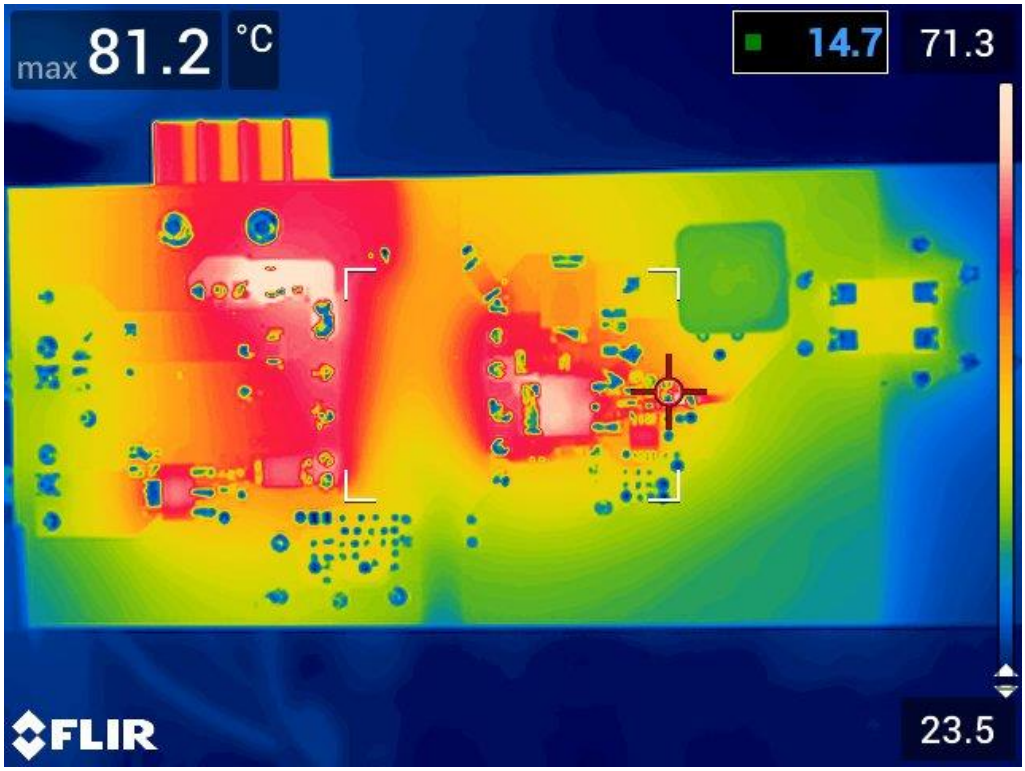
Vin RMS (V)	Line Frequency (Hz)	Pin (mW)
90	60	257.4
120	60	296.8
230	50	582.9
265	50	722.2

2.5 Thermal Images

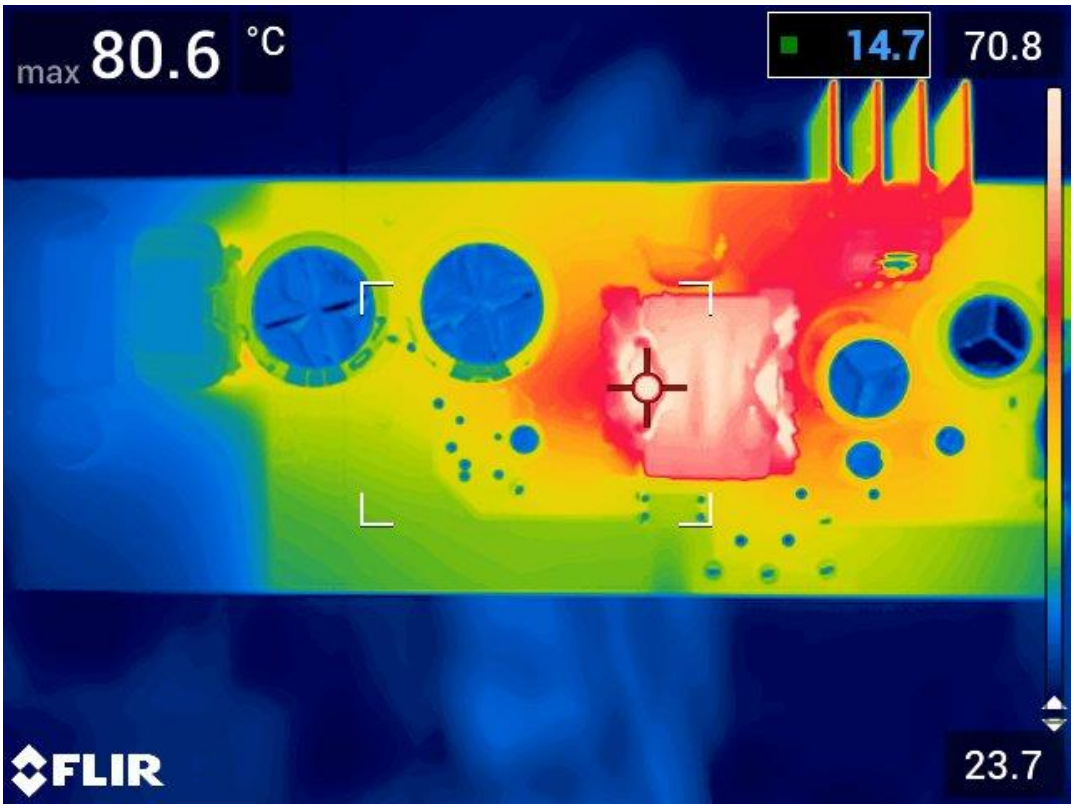
Thermal images were taken at an ambient temperature of 23 ºC, with no additional airflow, after 30 minutes of power on time.

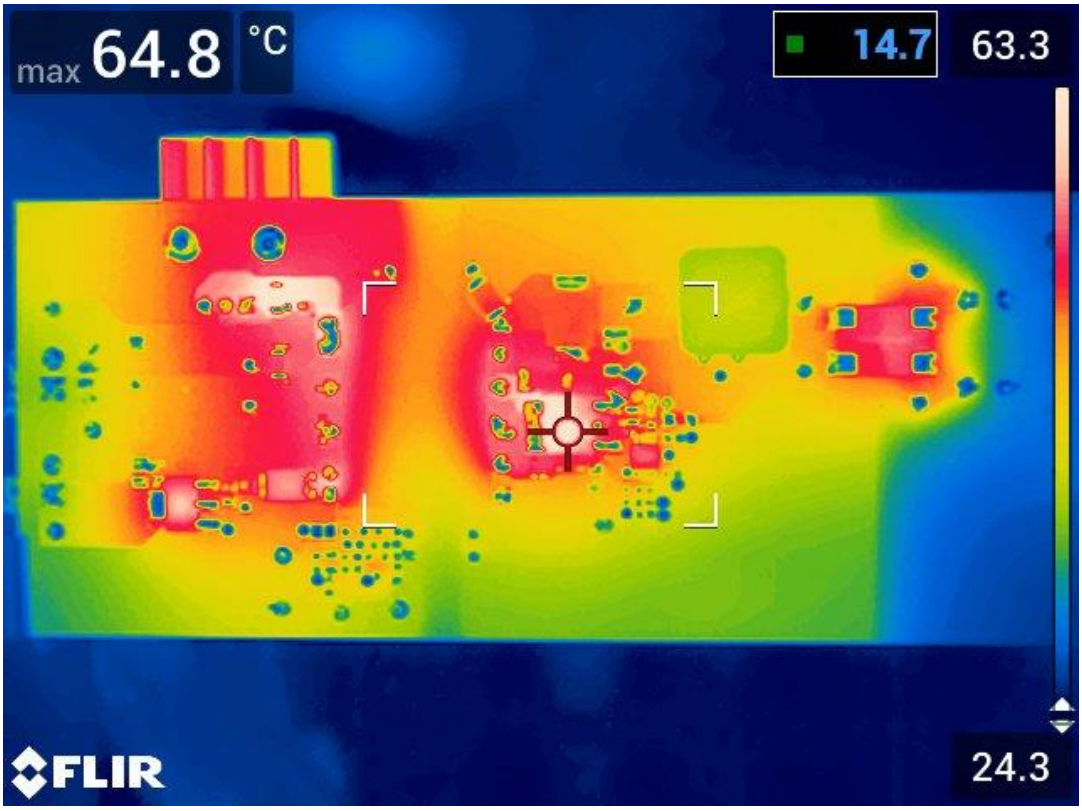
2.5.1 230VAC, 24V/2.25A Output



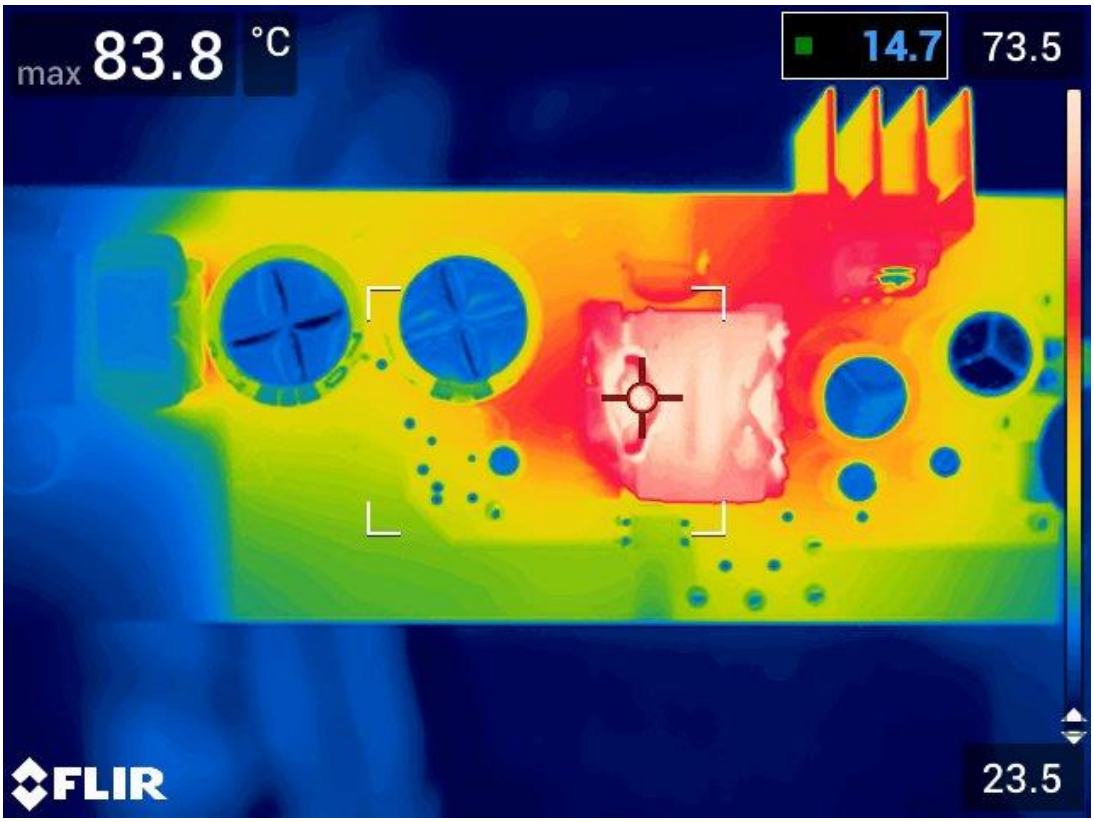


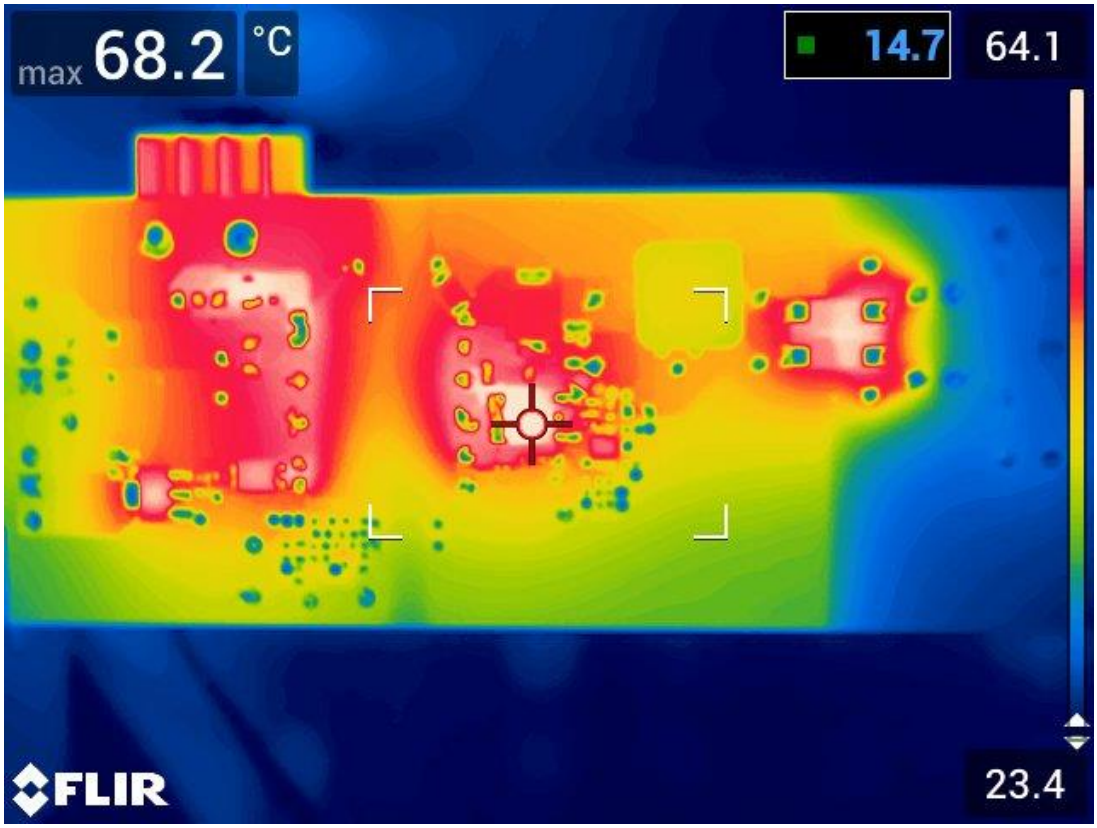
2.5.2 120VAC, 24V/2.25A Output





2.5.3 90VAC, 24V/2.25A Output

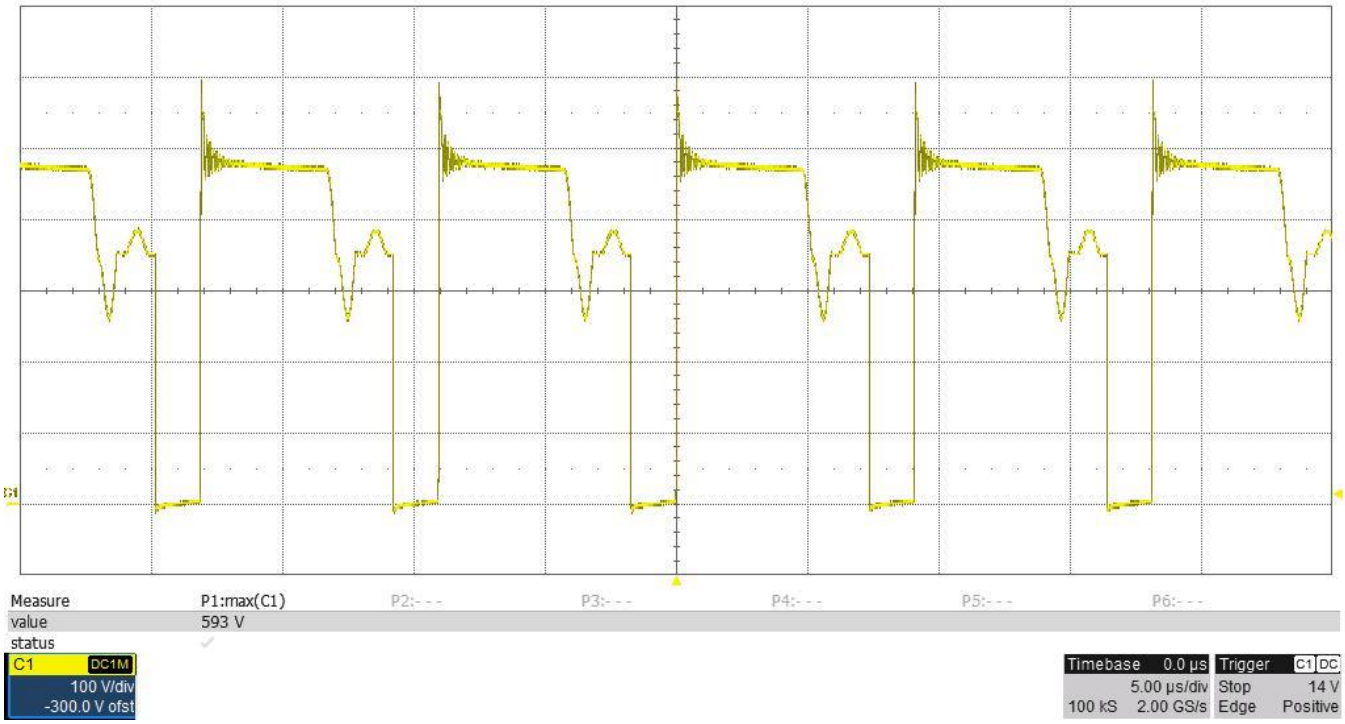




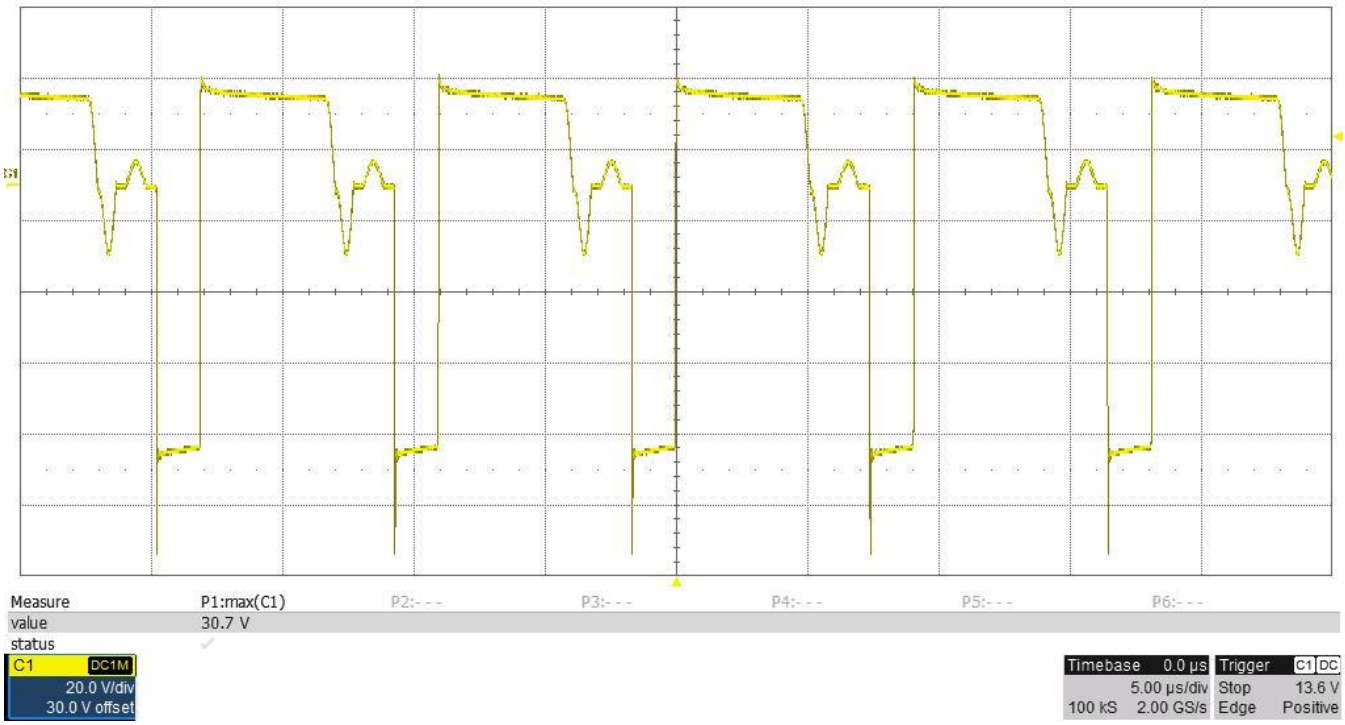
3 Waveforms

3.1 Switching

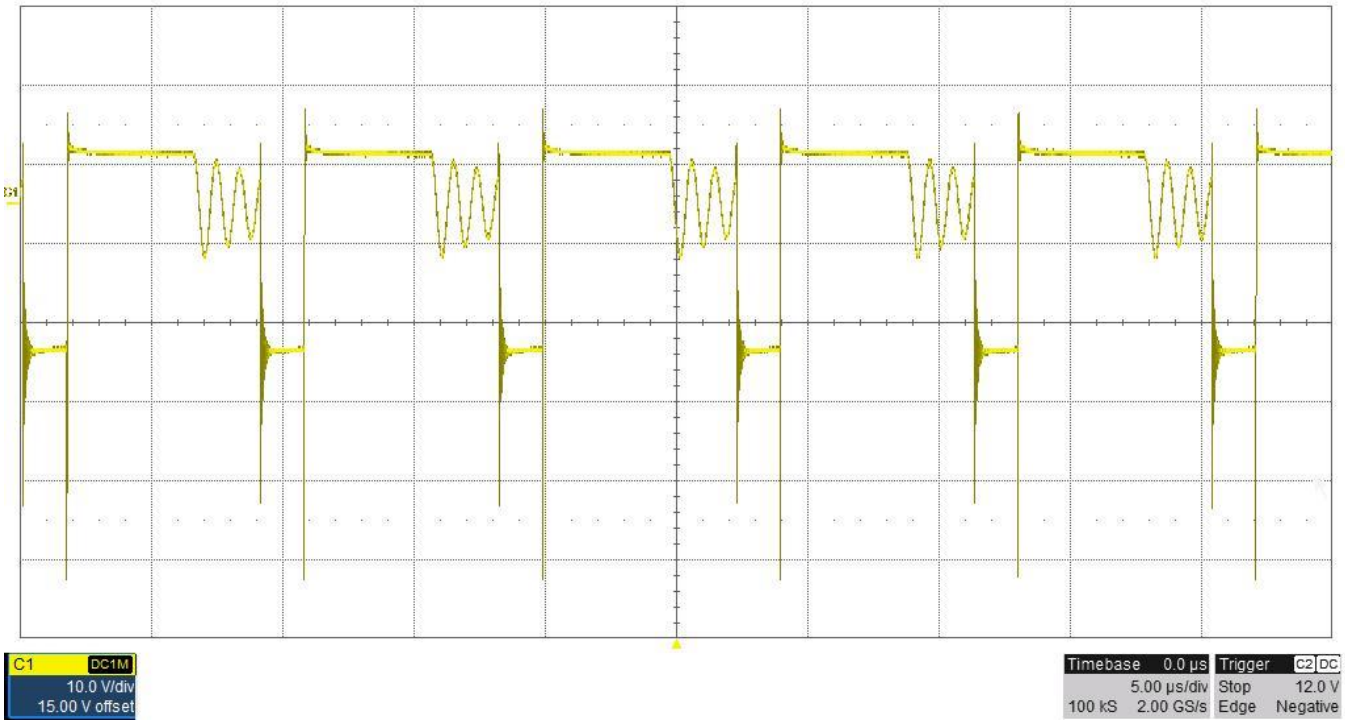
3.1.1 Vds of Primary FET (Q1), 265VAC Input, 24V/4.5A Output



3.1.2 Voltage across 24V Output Rectifier (D1), 265VAC Input, 24V/4.5A Output

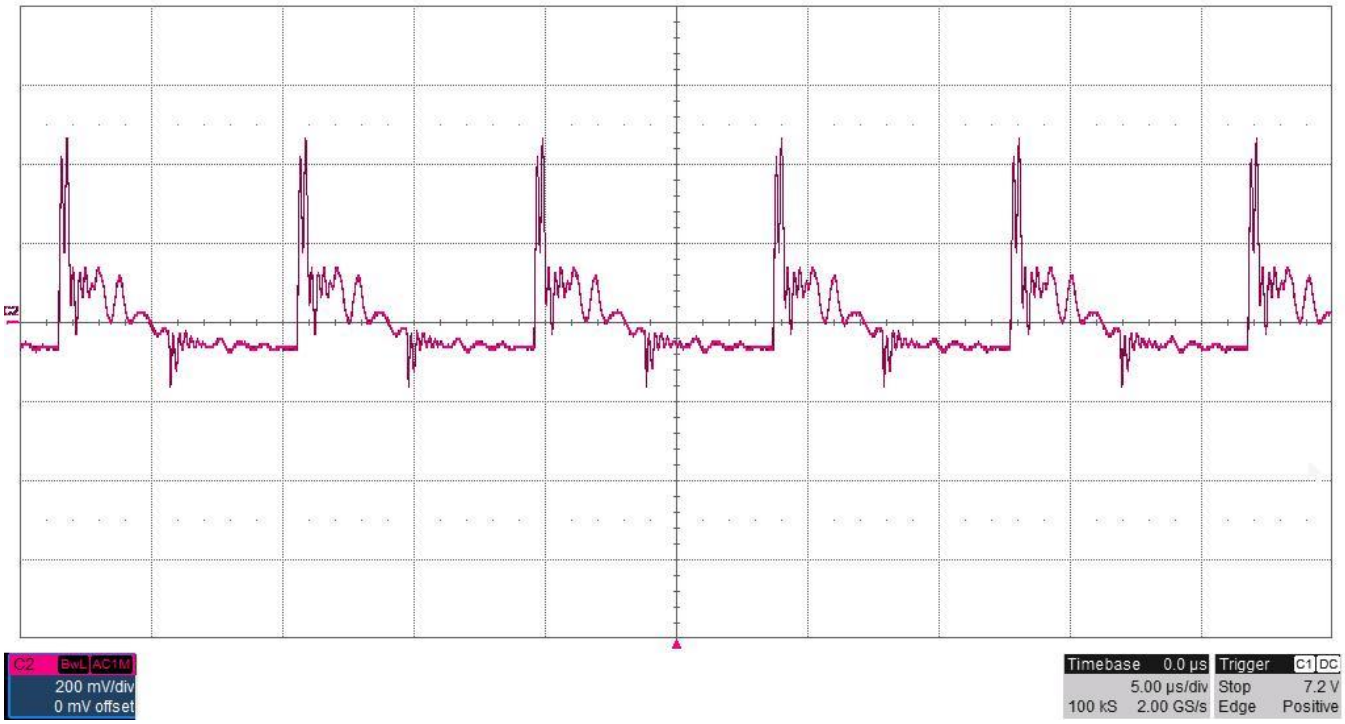


3.1.3 Voltage across 6V Output Rectifier (D5), 265VAC Input, 24V/4.5A Output

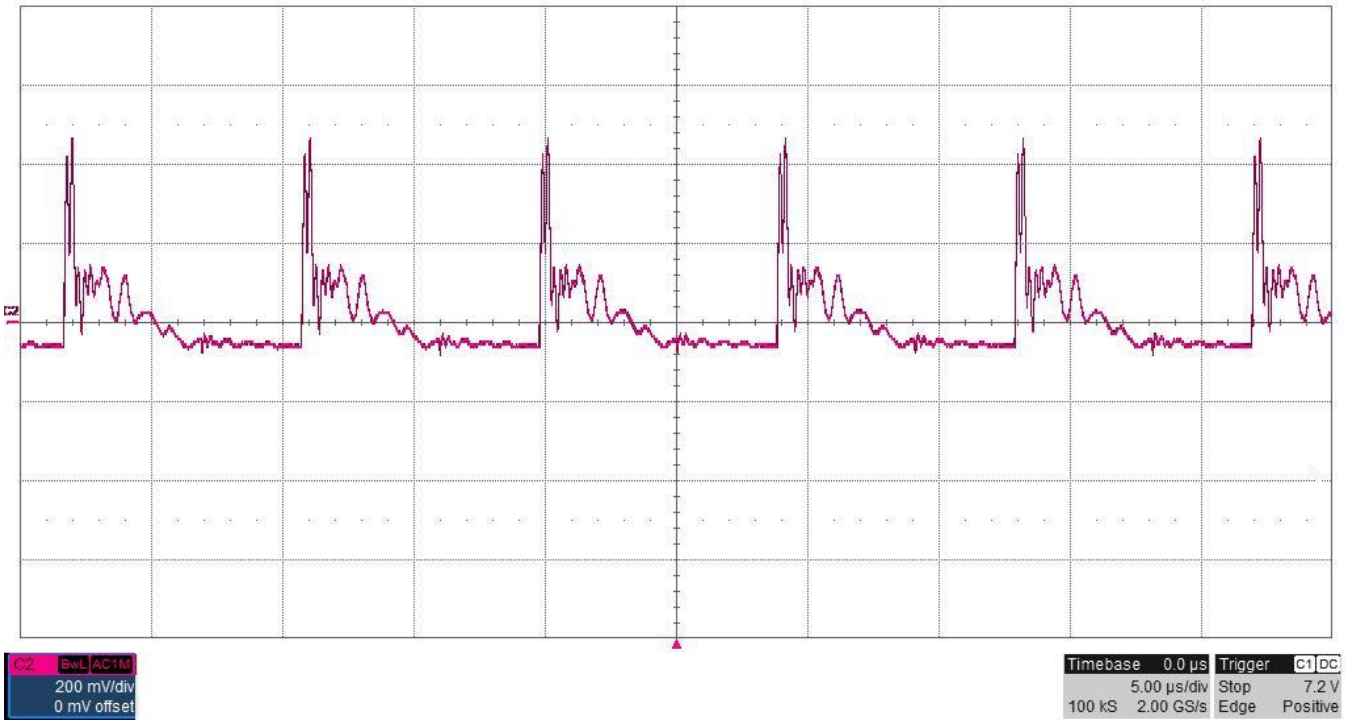


3.2 Output Voltage Ripple

3.2.1 230VAC Input, 24V/4.5A Output

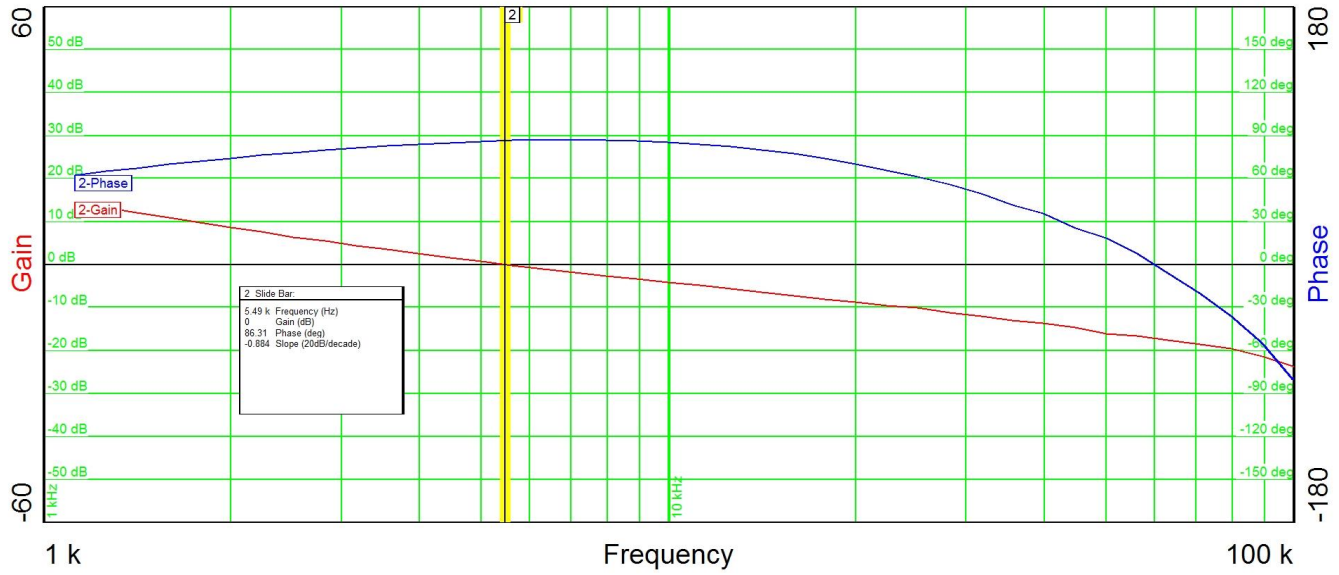


3.2.2 120VAC Input, 24V/4.5A Output

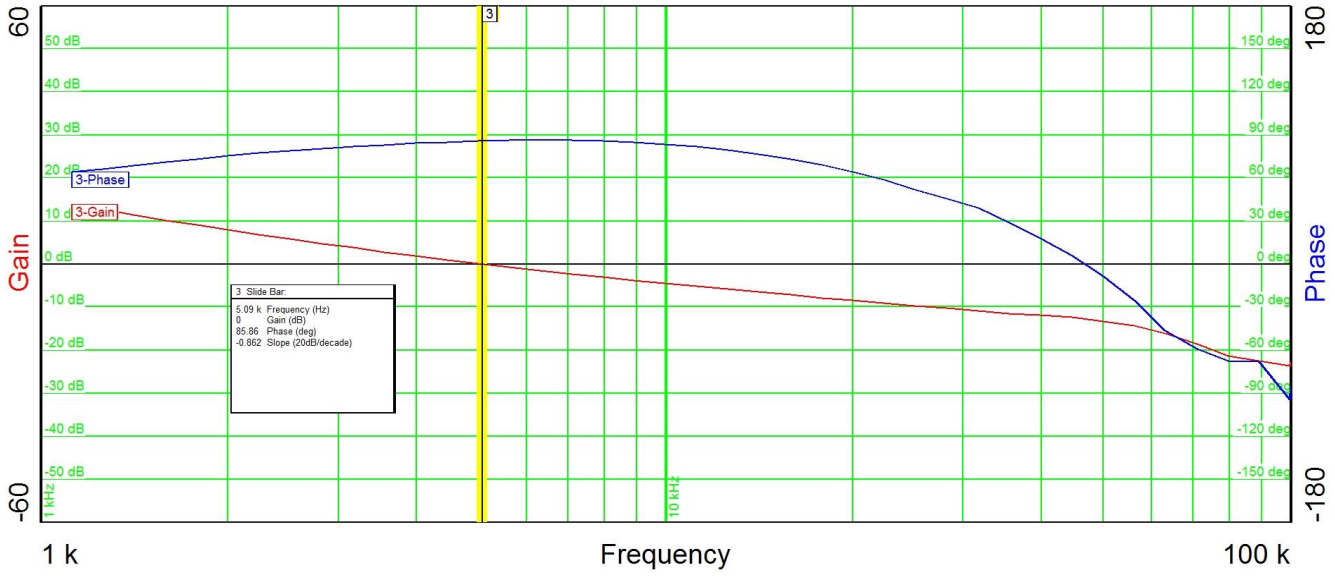


3.3 Bode Plot

3.3.1 230VAC Input, 24V/4.5A Output

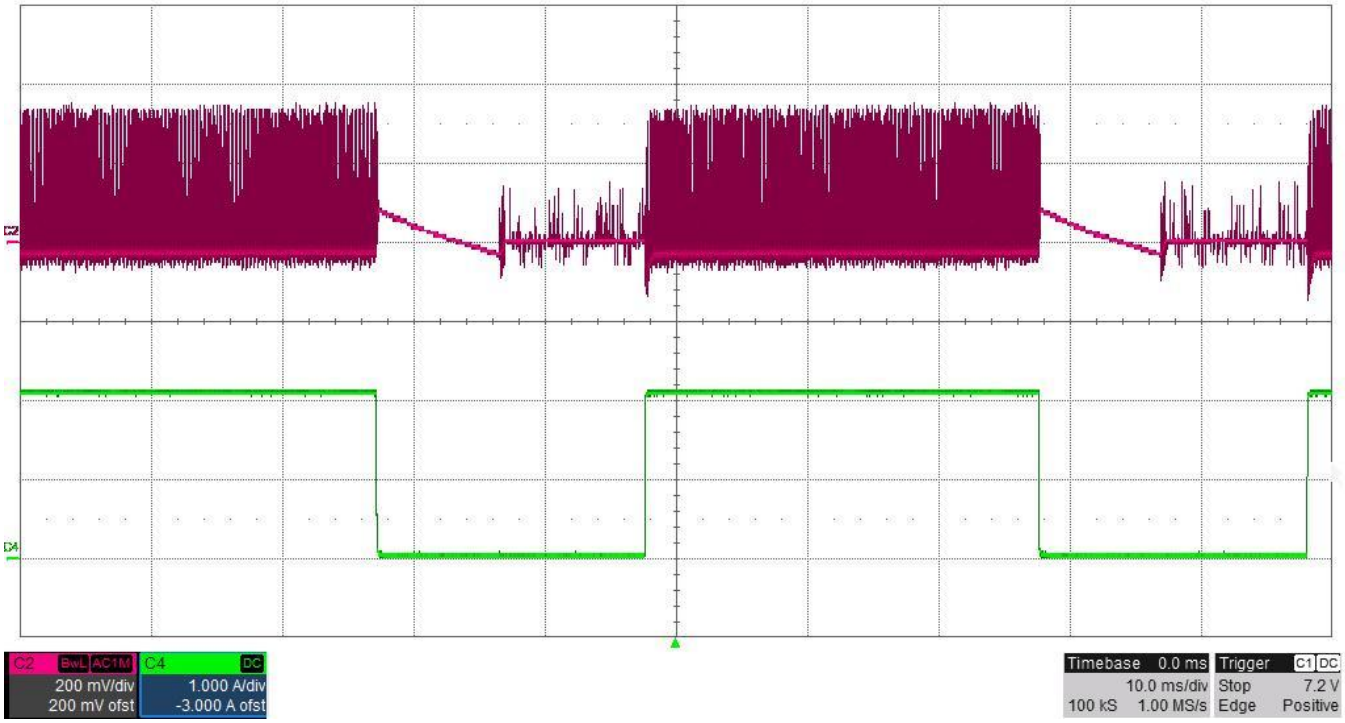


3.3.2 120VAC Input, 24V/4.5A Output

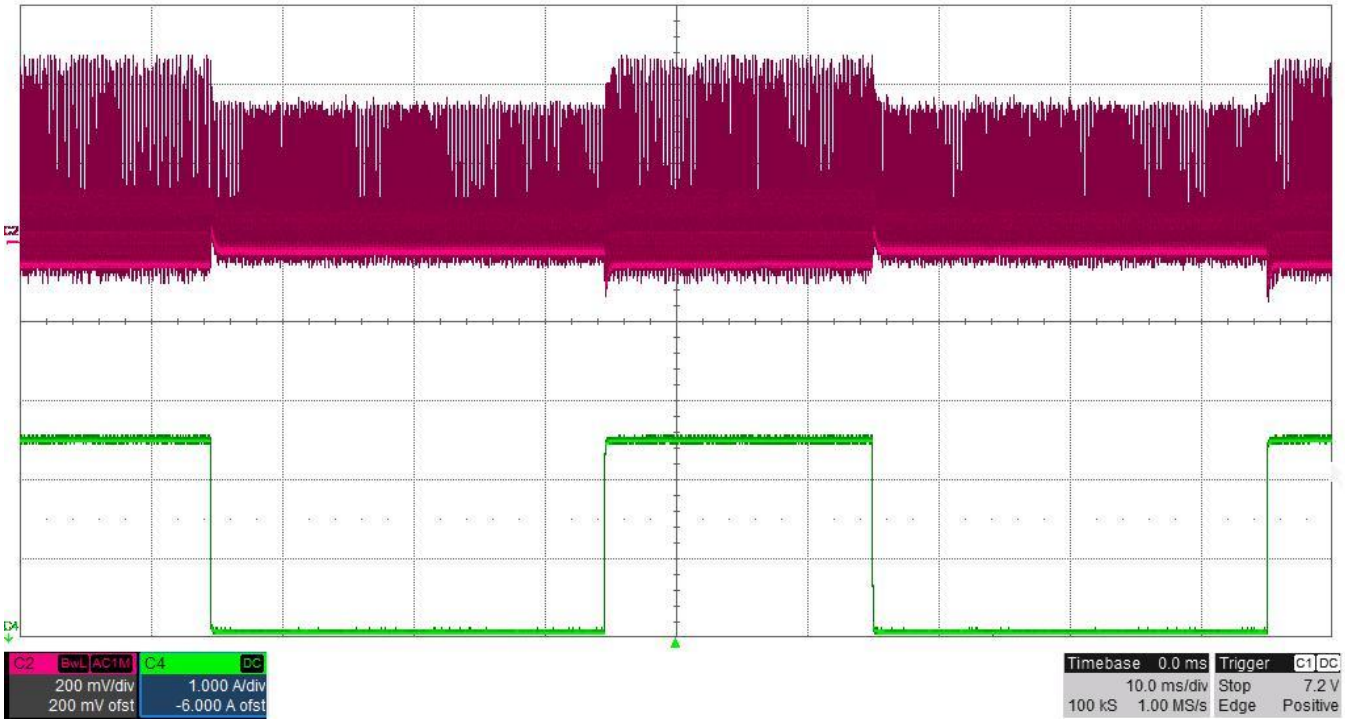


3.4 Load Transients

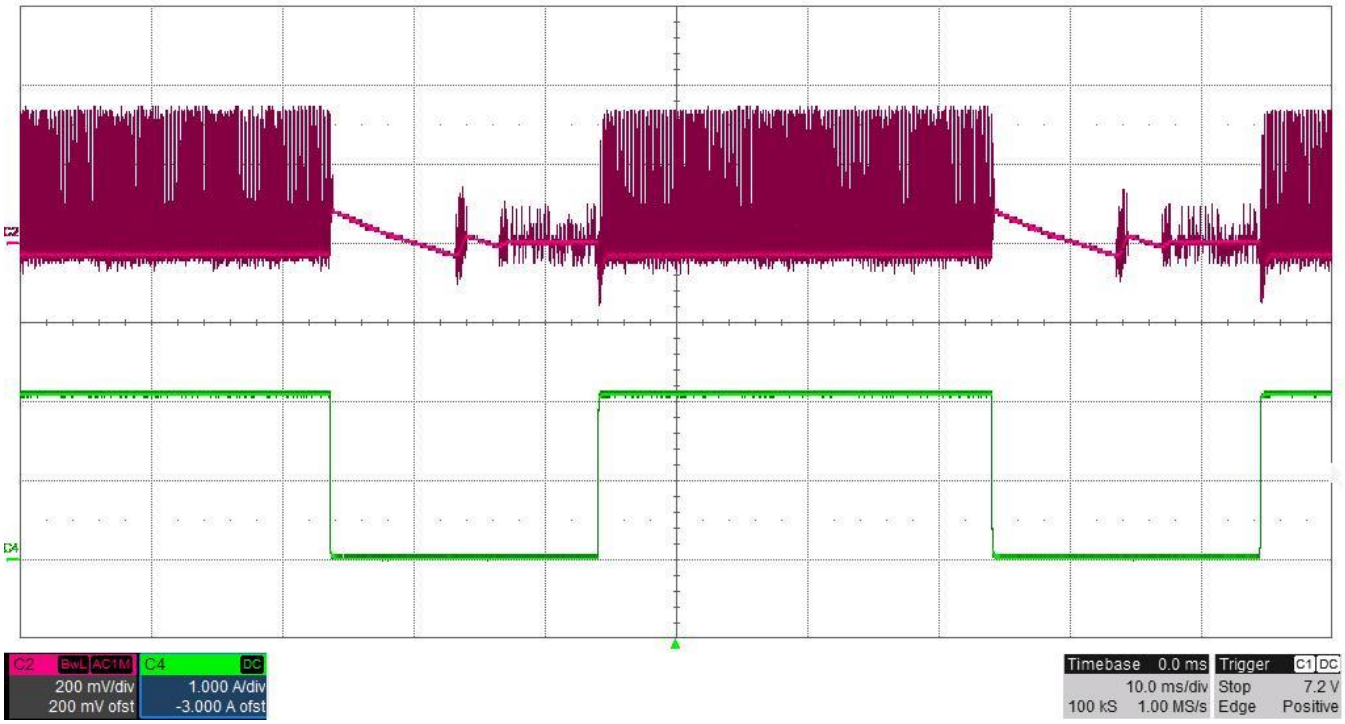
3.4.1 230VAC Input, 0A to 2A, 24V Output



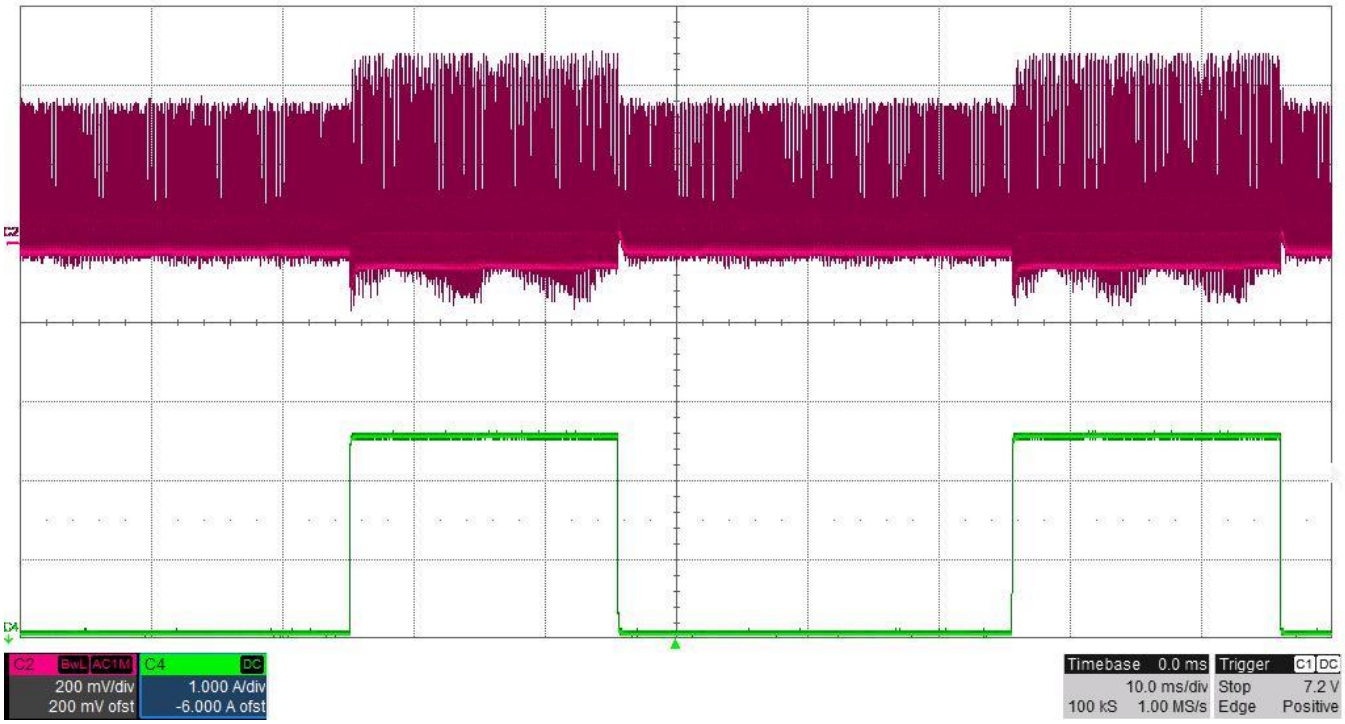
3.4.2 230VAC Input, 2A to 4.5A, 24V Output



3.4.3 120VAC Input, 0A to 2A, 24V Output

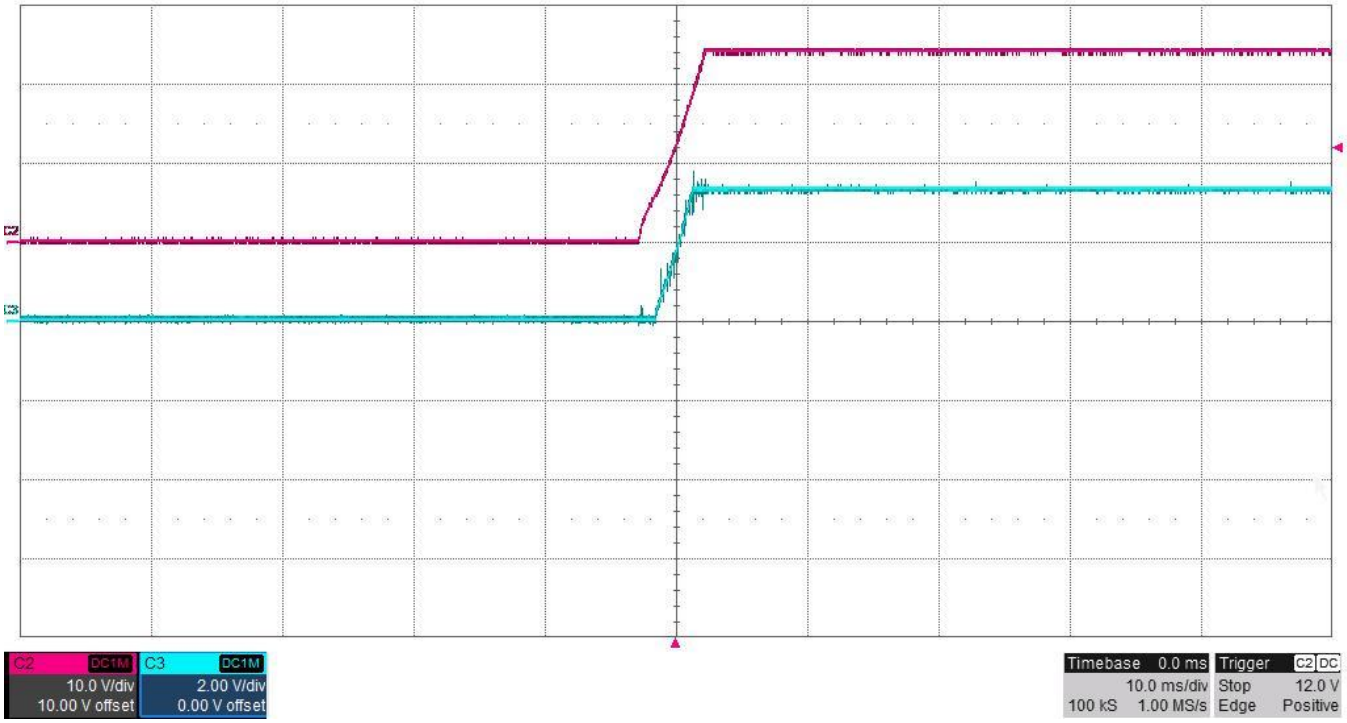


3.4.4 120VAC Input, 2A to 4.5A, 24V Output

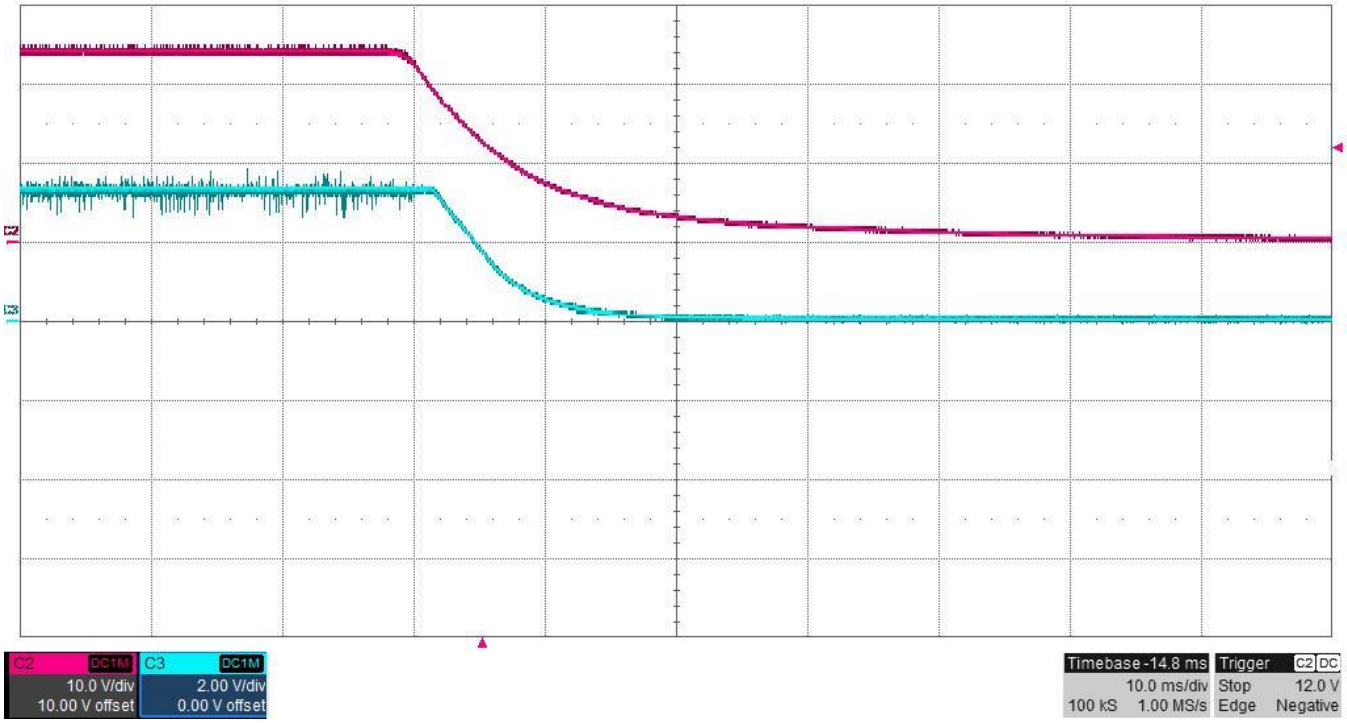


3.5 Start/Stop Sequence

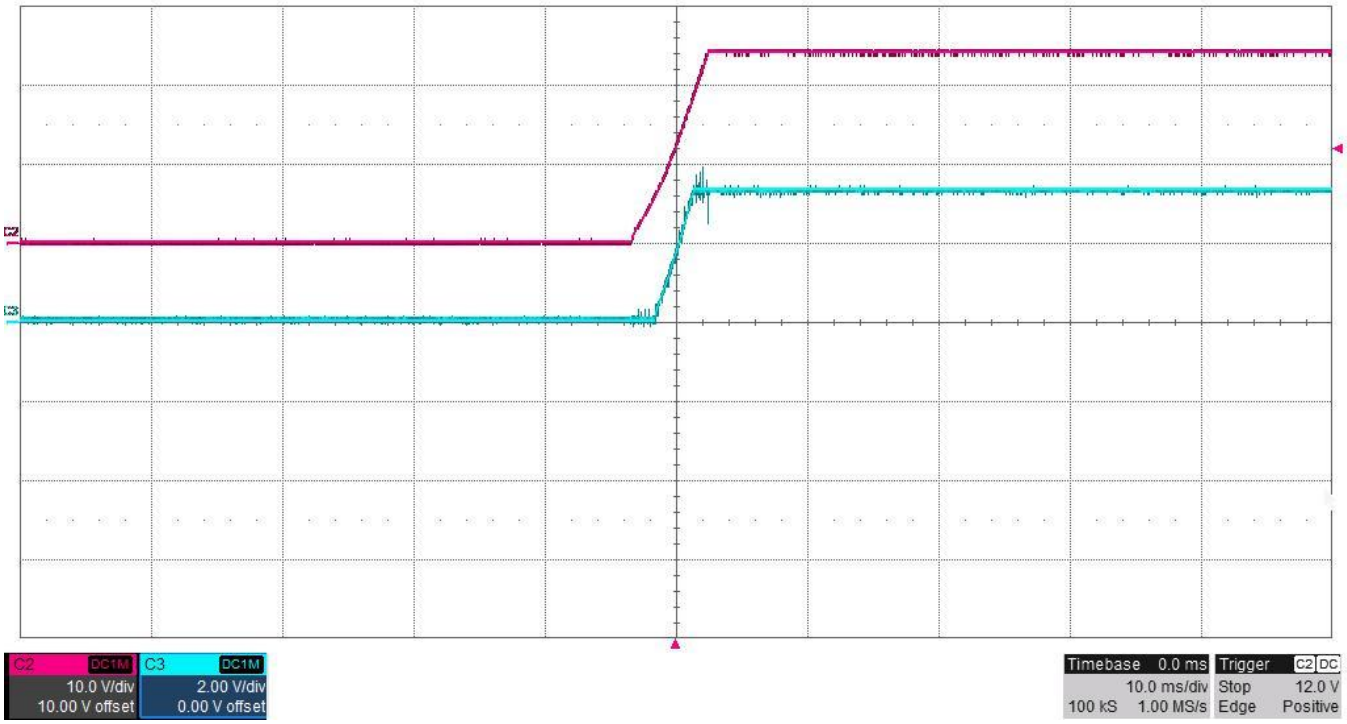
3.5.1 230VAC Input, Start Unloaded



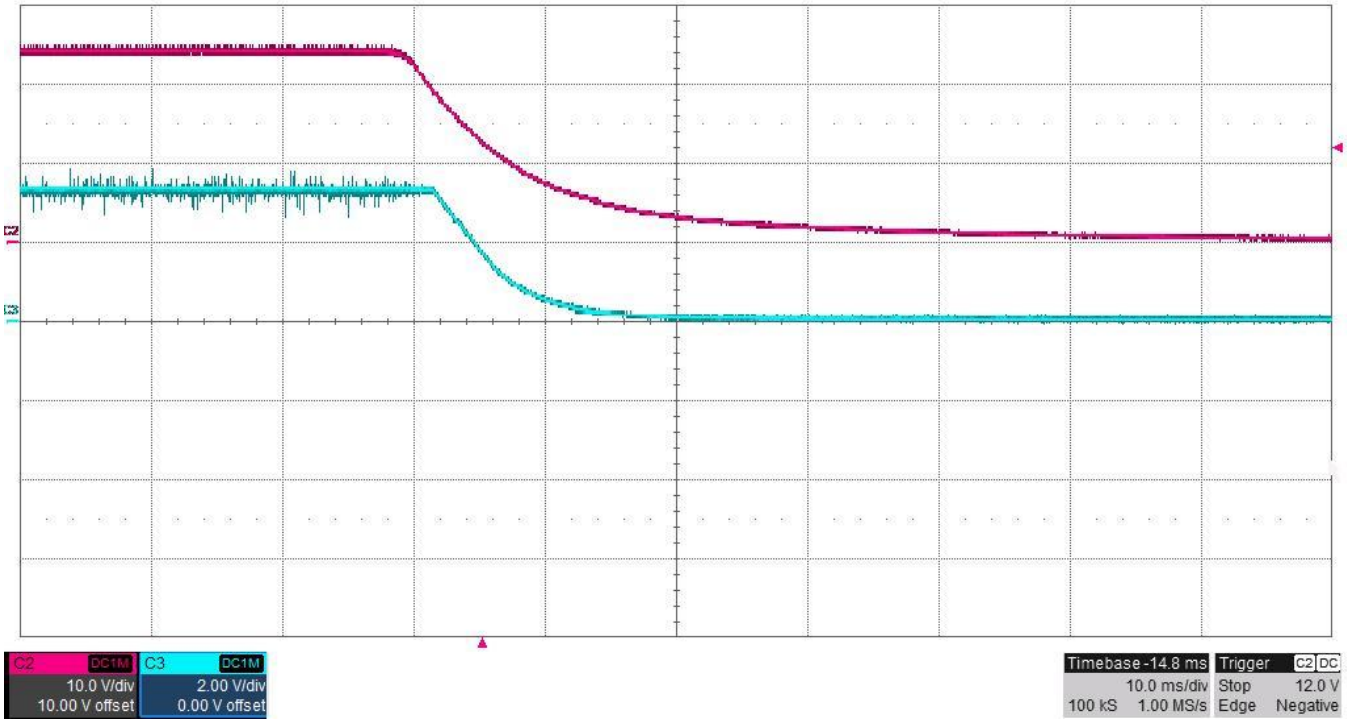
3.5.2 230VAC Input, Stop Full Load



3.5.3 120VAC Input, Start Unloaded

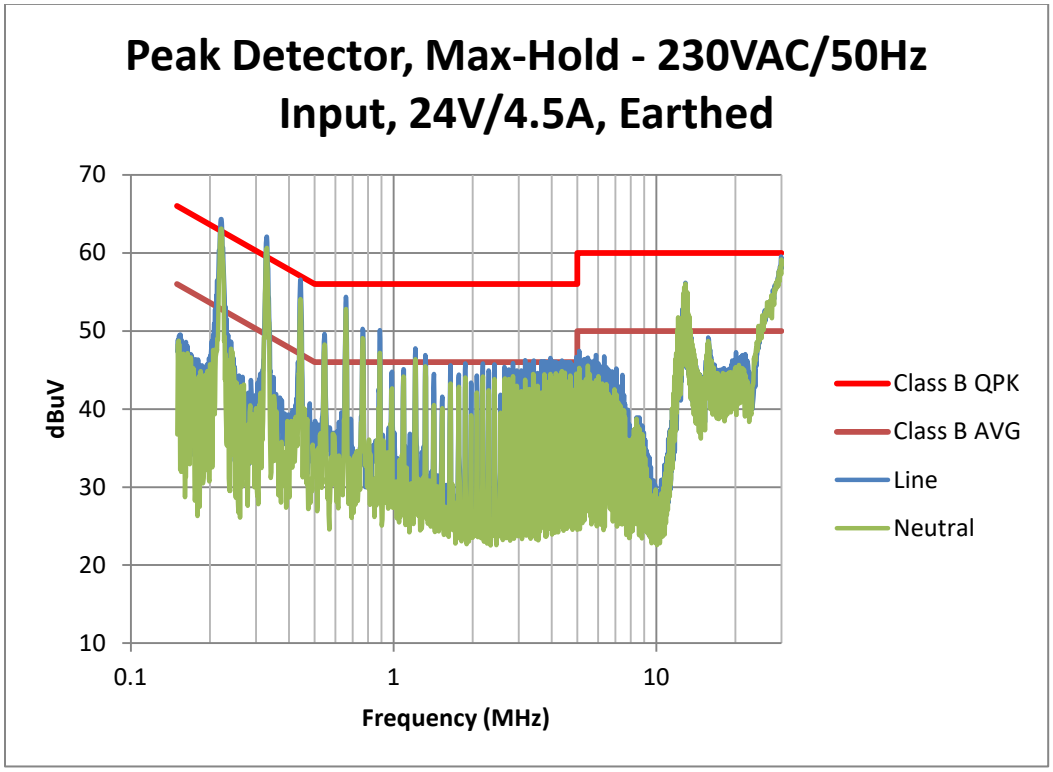


3.5.4 120VAC Input, Stop Full Load

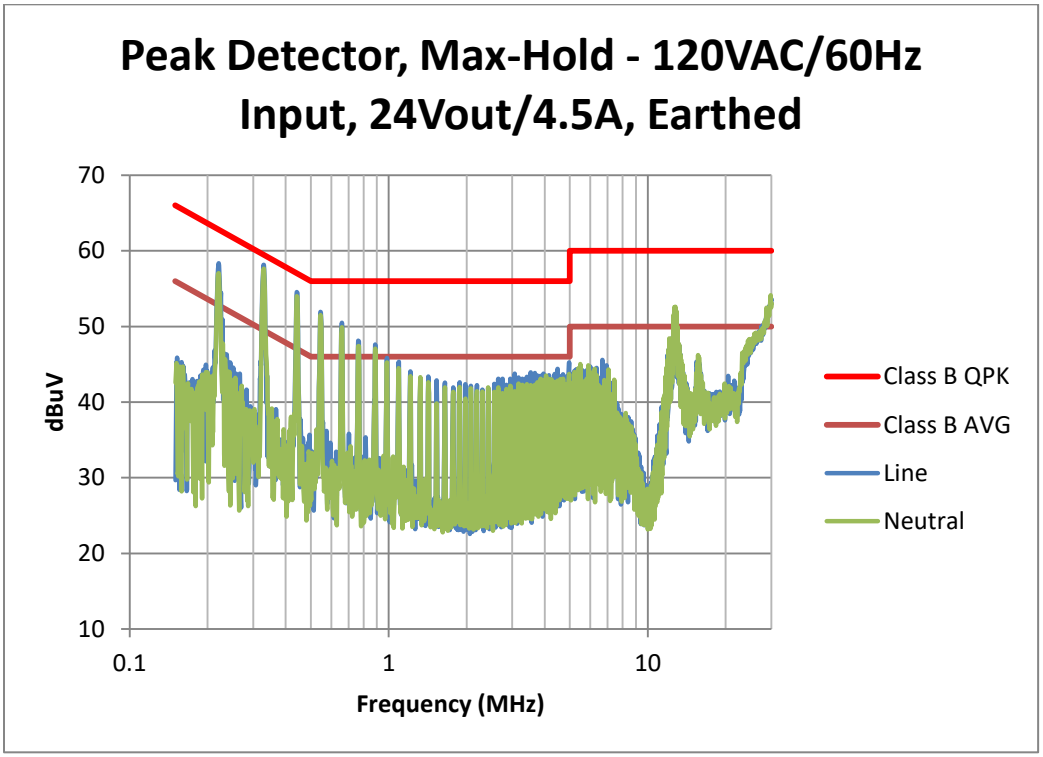


3.6 Conducted EMI

3.6.1 230VAC Input, Full Load, Earthed



3.6.2 120VAC Input, Full Load, Earthed



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